CLAIMS

1. A method for determining imaging and process parameter settings of a lithographic pattern imaging and processing system, the method comprising:

correlating the dimensions of a first set of control patterns printed in a lithographic resist layer, measured at two or more locations on or within each pattern that correspond to different optimum focus settings, to the dose and focus settings of the pattern imaging system to produce dependencies;

measuring the dimensions on subsequent sets of control patterns printed in a lithographic resist layer at two or more locations on or within each pattern, of which a minimum of two locations corresponding to different optimum focus settings match those measured in the first set; and

determining the effective dose and defocus values associated with forming the subsequent sets of control patterns by comparing the dimensions at the matching locations with the correlated dependencies.

2. The method of claim 1 wherein the locations of the different optimum focus settings on or within a pattern correspond to different heights on a profile of the pattern in the resist layer.

3. The method of claim 2 wherein one of the heights comprises a reference height on the profile of the pattern at or near the bottom of the thickness of the resist layer.

4. The method of claim 1 wherein the set of control patterns is designed so that the correlated dependencies of its measured dimensions to dose and focus are decoupled from one another.

5. The method of claim 1 further including determining the dimensions of the subsequent set of control patterns at all measured and unmeasured locations for which the correlated dependencies have been determined by substitution of the effective dose and defocus values in the correlated dependencies.

6. The method of claim 1 wherein each of the control patterns has an isolated feature with a pitch greater than twice a width of an individual or repeating feature in a measurement direction.

7. The method of claim 1 wherein the measured dimensions of the first and subsequent sets of control patterns comprise widths of the printed control pattern features as measured at or near the top and bottom of the thickness of the resist layer.

8. The method of claim 6 wherein the widths at different heights of the subsequent sets of control pattern features are measured at different locations along the plane of the resist layer, and at different times.

9. The method of claim 1 wherein the dimensions of the first set of control patterns are measured in a calibration process, and the dimensions of the subsequent set of control patterns are measured in a production process.

10. The method of claim 1 wherein the correlated dependencies are created using a pre-determined parametric model, and determine optimum dose and focus settings for the pattern imaging system.

11. The method of claim 1 wherein the dimensions of the subsequent sets of control patterns widths are converted to deviations of effective exposure dose and defocus, which are then used to adjust exposure dose and focus settings in the lithographic pattern imaging and processing system.

12. The method of claim 1 further including correlating the dimensions of a first set of monitor patterns printed in a lithographic resist layer, measured at one or more locations on or within each monitor pattern, to the dose and focus settings of the pattern imaging system to produce dependencies; and

determining the dimensions of any monitor patterns printed simultaneously with the subsequent sets of control patterns, at all locations for which correlated dependencies of the monitor patterns on dose and defocus have been determined, by substitution of the effective dose and defocus values in the correlated dependencies of the monitor patterns.

13. A method of controlling imaging and process parameters in a lithographic process comprising:

providing a control pattern having an isolated feature with a pitch greater than twice a width of an individual or repeating feature in a measurement direction;

exposing a resist layer having a thickness on a calibration substrate with the control pattern design at a plurality of different exposure dose and focus settings;

developing the exposed resist layer to produce a calibration resist layer having a plurality of printed control patterns representing different exposure dose and focus settings, each control pattern having at least one printed feature;

for each exposure dose and focus setting, measuring width of the printed calibration control pattern feature at a plurality of different heights along the thickness of the resist layer;

determining optimum dose and focus settings from the measured widths at different heights of the printed calibration control pattern features and creating control pattern model parameters;

printing control patterns at fixed exposure dose and focus settings on a production substrate in a production process;

measuring width of the printed production control pattern features at a plurality of different heights along the thickness of the resist layer;

comparing the measured widths at different heights of the printed production control pattern features with the control pattern model parameters; and

adjusting imaging and process parameter settings in the production process based on the comparison of the measured widths at different heights of the printed production control pattern features and control pattern model parameters.

14. The method of claim 13 wherein, on the resist layer calibration substrate, the dose range encompasses a dose sufficient to produce a desired pattern dimension and the focus range encompasses optimum focus settings over a substantial portion of the thickness of the resist layer.

15. The method of claim 13 wherein the widths of the printed calibration and production control pattern features are measured at or near the top and bottom of the thickness of the resist layer.

16. The method of claim 13 wherein the widths at different heights of the printed production control pattern features are measured at different locations along the plane of the resist layer, and at different times during the process.

17. The method of claim 13 wherein the measured widths at different heights of the printed production control pattern features are converted to deviations of effective exposure dose and focus, and wherein the deviations of effective exposure dose and focus are used to adjust the imaging and process parameter settings in the production process.

18. The method of claim 13 further including providing a set of one or more monitor patterns;

exposing and developing the resist layer to print a plurality of calibration monitor patterns and one control pattern representing different exposure dose and focus settings in the resist layer;

for each exposure dose and focus setting, measuring width of the printed calibration monitor pattern features and the printed control pattern feature at a plurality of different heights along the thickness of the resist layer;

determining optimum dose and focus settings from the measured widths at different heights of the printed calibration monitor and control pattern features and creating monitor and control pattern model parameters;

printing control and monitor patterns at fixed exposure dose and focus settings on a production substrate in a production process;

computing the widths of the monitor pattern features at the plurality of heights for which model parameters have been determined; and

adjusting imaging and process parameter settings in the production process based on comparison of the measured widths of the control patterns and the computed widths of the monitor patterns and their dependencies on dose and focus.

19. The method of claim 18 wherein the widths of the printed calibration and production control pattern features are measured at or near the top and bottom of the thickness of the resist layer.

20. The method of claim 19 wherein the widths of the printed production control pattern features are measured at different locations along the plane of the resist layer, and at different times during the process.